Original Research Article

Money Market Indicators and Stock Market Volatility in Nigeria: Evidence from GARCH-in-Mean Model

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Abstract: This study examines the impact of money market variables on stock market volatility in Nigeria using an annual dataset from 1985 to 2021. Indicators of the money market, including certificates of deposit, commercial papers, bankers' acceptance, and treasury bills, were employed in the study. The Generalized Autoregressive Conditional Heteroskedasticity (GARCH-in mean) model was used to generate volatility of stock market index and a nexus between the variables. The findings showed that while commercial paper and treasury bills have no effect on stock market volatility in Nigeria, certificates of deposit and bankers' acceptance do. This study suggests increasing investment in money market indicators, particularly a certificate of deposit and bankers' acceptance, to lower investment risk and volatility of the stock market index.
Keywords: Money market indicators, stock market volatility, GARCH.
JEL Classification: D53, E44.

INTRODUCTION

Money and stock markets play a significant function in the monetary mediation of any country globally. A capable stock and money market can stimulate economic growth and provide a steady financial sector that facilitates an essential investment channel that contributes to and continue to attract domestic and foreign capital investment. However, stock and money markets serve as a fundamental tool for the sourcing and allocation of savings among competing uses that are critical to the economic growth and development of any nation (Ahmad *et al.,* 2015). The two markets constitute the Nigerian financial system. However, the main objective of the systems is to mobilize funds from the surplus spending units to the deficit spending units which in turn stabilizes the economy (Okoyan, & Eze, 2021).

The money market is an integral part and parcel of Nigeria's economy as it plays a vital role in the economic growth and development of the country (Aminu, Bambur, & Aliyu, 2017; Marshal, & Solomon, 2015). The presence of a money market enables trading in short-term debt instruments to meet up with short-term needs of potential users of funds such as individuals, banks, governments, and similar establishments and it is the market where securities on short-term bases of not more than one year are traded (Kizito, 2013; Pavtar,2016). The stock market on the other hand otherwise none as a capital market, accommodates a large chunk of the nation's wealth that provides the avenue for transacting long-term instruments, where capital for providing long-term investments that require long maturation periods can be raised (Babangida, 2021; Raifu, Kumeka, & Aminu, 2021).

Although the money market and stock market are independent. However, to some extent, they are interrelated in the sense that a slight shock or change in one is likely going to affect the other. Furthermore, the relevance and importance of money market indicators to the development of the stock market cannot be over-emphasized. This is connected to the fact that the link between the two markets has recently been a subject of interest in several articles. For instance, Olanrele, Adegunle and Fateye, (2018), and Aleke, *et al.,* (2022) reported that there is an inverse relationship between the money market indicators (treasury bills, certificate of deposit, commercial papers, bankers' acceptance, interbank-call rate, monetary policy rate, and savings deposits among others) and the Stock market return.

In light of the foregoing, there is a paucity of empirical studies on the relationship between money market indicators and stock market volatility most

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especially concerning how money market indicators such as treasury bills, certificates of deposit, commercial papers and bankers' acceptance affect stock market fluctuations. Previous studies (Olowe, 2007; Abraham 2011; Terfa, 2011; Aliyu, 2012; Osamwonyi & Evbayiro-Osagie 2012; Etale & Eze, 2019; Igoni, *et al.,* 2020; Omodero, 2020) on the stock market were largely concentrated on the reaction of the stock market to macroeconomic variables. Thus, this study sought to fill the research gap by estimating the nexus among the series. In addition, the majority of these studies use either autoregressive Conditional Heteroscedasticity (ARCH) or Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models in their analysis. However, this study applied a time- varying approach known as GARCH-in-mean to estimate the short-run and long-run impact of money market indicators on stock market volatility. Consequently, contrasting the ordinary GARCH model which permits for a constant mean reversion for all time, the time-varying volatility allows average-mean reversion to a varying at different time horizons.

The rest of the paper is systematized as follows; section two reviews the relevant empirical studies, section three presents the data and methodology section four is the result and discussion, and section four concludes the paper.

LITERATURE REVIEW

The theoretical support of this study is anchored on the Arbitrage Pricing Theory (APT) developed by Stephen Ross in the year 1976. The theory is the multi-factor asset pricing model based on the assertion that the return of an asset can be predicted via the linear relationship between the expected return of an asset and some monetary and macroeconomic indices that capture the risk and uncertainty. These indicators affect the discount rates and capability of firms to generate cash flows and dividend payments in the future (Ross, 1976). Thus, money market indicators and other macroeconomic variables are among the risk factors that influence the volatility of the stock market (Ouma & Muriu, 2014).

In addition to the foregoing, the empirical literature on the link between macroeconomic variables and stock volatility is abounding in several studies. For example, Adjasi (2009) used an exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model and a monthly time series dataset from January 1991-January 2007 in Ghana. The results show that shock in the prices of cocoa and interest rates leads to persistent volatility of the stock returns, whereas persistent volatility in gold prices, oil prices, and money supply declines the volatility of stock prices. Consequently, Thampanya Nasir and Liu, (2020) analyzed a monthly panel dataset from January 1995 to December 2018 for a sample of five Asian countries (Malaysia, Thailand, Singapore, Indonesia and the Philippines). Their results indicated that monetary policies play significant in determining stock market volatility. Also, Marozva (2020) in his study on the link of monetary policy to the volatility of stock market return in South Africa. By applying an annual time series dataset from 1995 to 2019 and correlation analysis, their results indicated that there is a positive correlation between interest rate and stock market return while exchange rate and the stock market return are negatively correlated.

Talla (2013) applied Ordinary Least Square (OLS) to estimate the effect of macroeconomic variables on the Stockholm stock exchange using a monthly time series dataset for the period 1993 to 2012. The results suggest that the inflation rate and exchange rate have a significant negative influence on the stock market while money supply and interest rate have no significant effect on the stock market. Also, Ouma and Muriu (2014) employed a monthly time series dataset to analyze the relationship between macroeconomic variables and stock returns in Kenya for the period 2003 to 2013 using Ordinary Least Square (OLS) regression. The results indicated that money supply and inflation rate have a significant positive influence on stock return while the exchange rate has a significant negative effect on stock market return. The results also suggest that interest rate has no significant influence on the rate of return.

Das and Megaravalli (2017) used quarterly observations from April 2005 to March 2015 to examine the connection between the Indian stock market and the chosen macroeconomic indicators. As macroeconomic factors, they look into account the exchange rate, foreign institutional investment; call money rate, and consumer price index (CPI). The study further used Pearson's correlation, the Johansen co-integration test, and the Granger causality test. According to their findings, there is a favourable association between macroeconomic factors and stock market indices, and evidence of long-term equilibrium. The Granger causality test also showed a causal relationship between the stock market index, exchange rates, and call money rates. Finally, Celebi and Honig (2019) examined the impact of macroeconomic factors on the German stock market using a quarterly time series dataset from the first quarter of 1991 to the second quarter of 2018. By applying an Ordinary Least Square (OLS) regression, the findings suggest that exchange rate and interest rate have a significant positive influence on the stock market while GDP, gross investment and money supply have a significant negative influence on stock market return.

However, empirical evidence in Nigeria finds that macroeconomic variables significantly affect stock market volatility. For instance, Aliyu (2012) applied GARCH and EGARCH in his study and the results show that broad money (M2) and monetary policy rate

lead to a disrupting effect on stock market returns in Nigeria. However, Aleke *et al.,* (2022) applied GARCH in their study and found that volatility in Treasury bill rates and monetary policy rates have a significant negative effect on the volatility of stock market returns in Nigeria. Similarly, Okoyan and Eze (2021) used Johansen cointegration and vector error correction approaches in modelling time series datasets from 1981 to 2018 in Nigeria. Their results suggested that treasury bills and commercial paper have negatively influenced the performance of the capital market while there is a significant positive connection between bankers' acceptance and capital market growth rate.

In addition, Etale and Eze (2019) analyzed the linkages between macroeconomic variables and stock market performance using an annual time series dataset from 1985 to 2017. By applying Johansen cointegration test and Error Correction Model (ECM), the study shows that broad money supply and the exchange rate exert a significant positive effect on stock market growth, while interest rate and inflation rate adversely affect stock market performance. Lastly, Evbayiro-Osagie and Kehinde (2015) applied the GARCH model and an annual time series dataset for the period 1985 to 2015 to examine the relationship between inflation rates, financial openness, exchange rates and stock market returns volatility in Nigeria. Their findings suggest that the exchange rate has significant positive return volatility while the inflation rate has a significant negative influence on stock market return volatility.

DATA AND METHODOLOGY

In conducting this study, annual data was sourced from the Central Bank of Nigeria statistical bulletin, the data covered the period from 1985 to 2021 for all the variables. The all-share index was used as a measure or proxy of the stock market. The money market indicators used are a certificate of deposit, commercial papers, bankers' acceptance and treasury bills. However, the variables were converted to natural logarithms for normalizations. In addition, the volatility of the variables was generated with the main purpose of arriving at robust and reliable outcomes.

In modelling how money market indicators influence the volatility of the stock market index in Nigeria, this paper used the GARCH in mean (GARCH-M) model. GARCH-M is a time-varying stochastic volatility model used in analyzing the effect of stock index risk, squared residual, residual variance and other regressors on the volatility of the stock market index. In addition, the time-varying volatility (GARCH-M) model allows mean reversion to change at different time horizons contrasting the normal GARCH model which allows only constant mean reversion to vary all the time. Therefore, the standard GARCH-M (p,q) model is stated as:

$$\delta_t^2 = \varphi + \sum_{k=1}^{p} \phi_k \chi_{t-k} + \sum_{i=1}^{p} \gamma_i \mu_{t-i}^2 \quad \dots\dots\dots\dots\dots\dots\ 1$$

Where δ_t^2 represents the volatility, φ, ϕ and γ are the coefficients of the estimated parameters of time-varying volatility model while μ_{t-i}^2 error terms or squared residual.

RESULTS

This section contains the results of the estimation. The results are divided into descriptive statistics and inferential analysis. Beginning with results of descriptive statistics of the variables is presented in Table 1.

Table 1: Result of Descriptive Statistics

Statistic	LASI	LCD	LCP	LBA	LTB
Mean	11.2980	1.1771	2.2616	1.7428	6.0031
Std. Dev.	1.9126	2.7902	2.3117	2.6202	1.7348
Skewness	-0.8987	-0.2787	0.0901	-1.1954	-0.4354
Kurtosis	2.4031	1.7475	2.1188	3.1386	1.9272
Jarque-Bera	5.5298	1.8011	1.2471	8.8424	2.9433
Probability	0.0629	0.4063	0.5360	0.0120	0.2295
Observations	37	37	37	37	37

Sources: Authors' computation from Eviews version 10.

It is indicated that all the series have positive mean. This implies that over the sampled period, the series has recorded a positive growth rate. It also reveals that the certificate of deposit is more volatile in the distribution because of the higher standard deviation. It is also recorded that all the variables are normally distributed except bankers' acceptance due to significant probability value of the variable.

Table 2: Result of unit root test

Variables	Augmented Dickey-Fuller		Order of integration
	Levels	1st Difference	
All share index	-1.0455	-5.4032	I(1)
Certificate of deposit	0.9051	-7.0700	I(1)
Commercial papers	-2.1394	-5.3564	I(1)
Bankers; acceptance	-1.9773	-6.7403	I(1)
Treasury bills	3.9573	-3.5918	I(1)

Sources: Authors' computation from Eviews version 10

The result of a pre-estimation test from the Augmented Dickey-Fuller (ADF) indicated that all the variables are stationary after the first difference and found to be integrated with order one (i.e., I(1)). This implies that the series is not stable and experiences episodes of volatility over the sampled period.

Table 4: Results of Stock Index Volatility and Money Market Indicators

Conditional Mean Equation				
Parameter	Coefficient	Std. Error	z-Statistic	Prob.
φ	14.6784	0.0175	834.8271	0.0000
$\beta_{\alpha-1}$	0.9391	3.25E-0	289329.3	0.0000
Intercept	-3.1986	0.0040	-791.7372	0.0000
Variance Equation				
ϖ	0.1072	0.0001	942.9084	0.0000
h	0.3154	0.2392	1.3188	0.1872
β_{cd}	-0.0167	0.0012	-13.1186	0.0000
β_{cp}	-0.0238	0.0572	-0.4161	0.6773
β_{ba}	-0.2977	0.0662	-4.4960	0.0000
β_{tb}	-0.0003	0.0013	-0.2802	0.7793
Intercept	0.0565	0.0246	2.2929	0.0219

Sources: Authors' computation from Eviews version 10.

Table 3 contains the results of the time-varying volatility (GARCH-M) model. However, the results are divided into two parts. The first part of the results is the conditional mean equation of the GARCH-M model. This part measures the average influence of previous stock market index shock and risk (standard deviation of the GARCH-term) of having more episodes of volatility on the current volatility of the stock market index or otherwise. However, the second part is the conditional variance equation which measures the effect of previous period squared residual, residual variance and money market indicators on stock market volatility.

However, the results indicated that the coefficient of the standard deviation (i.e., a parameter of GARCH-term) for the stock market is positive and statistically significant at a 1% level. Thus, this implies evidence of risk of investment in the Nigerian stock market. The result also reveals that the coefficients of the previous stock market index carry positive signs and are statistically significant at a 1% level. This means that the average change in the previous stock market index by let's say 1% will lead to an increasing stock market volatility by about 0.93%.

However, from the conditional variance equation, the results show that the certificate of deposit and bankers' acceptance bears negative signs and are statistically significant at a 1% level. This implies that changes in these instruments (certificate of deposit and bankers' acceptance) will reduce the volatility of the stock market index in Nigeria. This is expected because as investors shift their investment in the money market, the inflows of a fund in the stock market will reduce which negatively pass-through to the stock market index. Similarly, commercial paper and treasury bills have a negative but statistically insignificant coefficient, suggesting that commercial paper and treasury bills have no strong influence on the volatility of the stock market in Nigeria.

A diagnostic was conducted on the model to check the robustness and reliability of its forecasting power. The results presented in figure 1 and figure 2, attested that the model seems to perform well going by the boundary of the forecasting error. The error is negligible, which shows the power of the model to forecast stock market volatility with a positive margin of error.
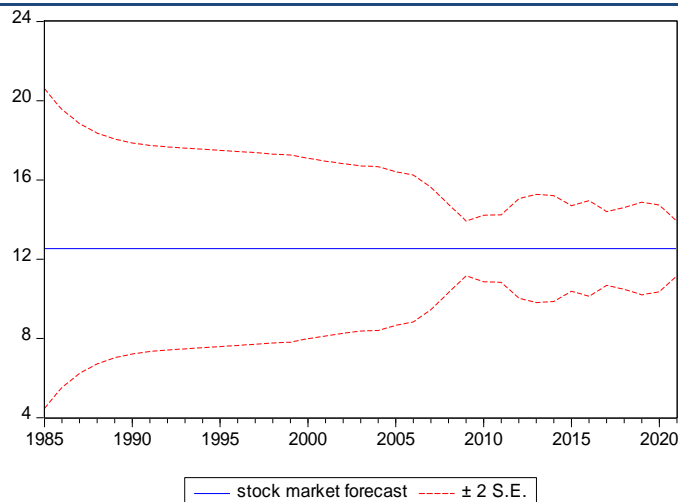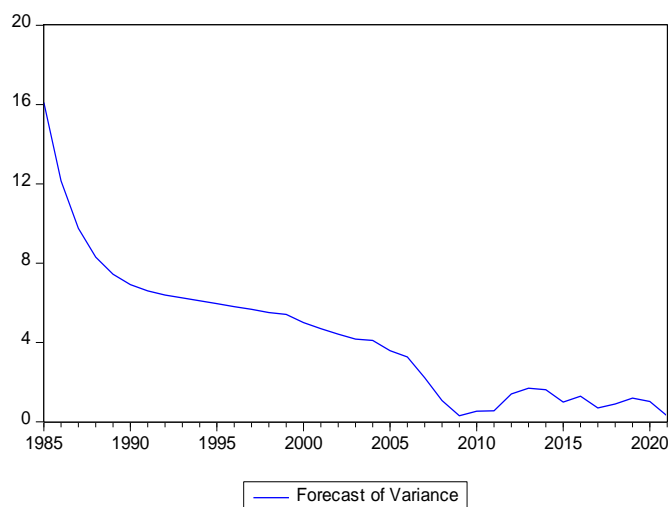
Figure 1: Stock Market Forecast

Figure 2: Forecast of Variance

CONCLUSION AND RECOMMENDATION

In the core area of the financial market, short-term borrowing is done via money market instruments. Therefore, increased short-term fund demand will either directly or indirectly impact the stock market index's volatility. Based on the aforementioned, this study investigates how Nigerian stock market volatility is affected by money market indicators. According to the findings, there is evidence of risk when investing in the stock market and historical data on the stock market index plays an average important role in predicting the present volatility of the stock market in Nigeria. Additionally, the results imply that bankers' acceptance and certificates of deposit have a major adverse impact on the volatility of the Nigerian stock market. However, the analysis discovers that neither commercial paper nor treasury bills have any effect on Nigeria's stock market volatility. This study suggests increasing investment in money market indicators, particularly the certificate of deposit and bankers' acceptance, to reduce stock market volatility.

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